silicon carbide (SiC) or gallium nitride (GaN), or wide band-gap semiconductors such as diamond can be also used as the semiconductor.

[0097] In the description of the above embodiments, the power semiconductor device is illustratively a MOSFET. However, the invention is suitably applicable to any power semiconductor devices having a superjunction structure. For example, the invention is applicable to SBDs, pin diodes, or IGBTs (insulated gate bipolar transistors).

1. A power semiconductor device comprising:
a semiconductor substrate;
a gate insulating film;
a control electrode insulated from the semiconductor substrate by the gate insulating film;
a first main electrode provided on a lower surface side of the semiconductor substrate; and
a second main electrode provided on an upper surface side of the semiconductor substrate,
the semiconductor substrate including:
a first first-conductivity-type semiconductor layer with its lower surface connected to the first main electrode;
a second first-conductivity-type semiconductor layer and a third second-conductivity-type semiconductor layer formed on the first first-conductivity-type semiconductor layer and alternately arranged parallel to the upper surface of the semiconductor substrate;
a trench formed in a directly overlying region of the third second-conductivity-type semiconductor layer, with part of the second main electrode buried in the trench;
a fourth second-conductivity-type semiconductor layer selectively formed in a surface of the second first-conductivity-type semiconductor layer and connected to the second main electrode;
a fifth first-conductivity-type semiconductor layer selectively formed in a surface of the fourth second-conductivity-type semiconductor layer and connected to the second main electrode; and
a sixth second-conductivity-type semiconductor layer formed at a bottom of the trench and connected to the second main electrode,
impurity concentration in the sixth second-conductivity-type semiconductor layer being higher than impurity concentration in the fourth second-conductivity-type semiconductor layer, and
lower surface of the sixth second-conductivity-type semiconductor layer being located below lower surface of the fourth second-conductivity-type semiconductor layer.

2. The power semiconductor device according to claim **1**, wherein
impurity amount in at least one of the second first-conductivity-type semiconductor layer and the third second-conductivity-type semiconductor layer varies in thickness direction of the semiconductor substrate,
in an upper part of a portion composed of the second first-conductivity-type semiconductor layer and the third second-conductivity-type semiconductor layer, the impurity amount in the third second-conductivity-type semiconductor layer is larger than the impurity amount in the second first-conductivity-type semiconductor layer, and
in a lower part of the portion composed of the second first-conductivity-type semiconductor layer and the third second-conductivity-type semiconductor layer, the impurity amount in the third second-conductivity-type semiconductor layer is smaller than the impurity amount in the second first-conductivity-type semiconductor layer.

3. The power semiconductor device according to claim **2**, wherein impurity amount in at least one of the second first-conductivity-type semiconductor layer and the third second-conductivity-type semiconductor layer varies continuously in thickness direction of the semiconductor substrate.

4. The power semiconductor device according to claim **2**, wherein impurity amount in at least one of the second first-conductivity-type semiconductor layer and the third second-conductivity-type semiconductor layer varies stepwise in thickness direction of the semiconductor substrate.

5. The power semiconductor device according to claim **1**, wherein depth of the trench is substantially equal to junction depth of the fourth second-conductivity-type semiconductor layer.

6. The power semiconductor device according to claim **1**, wherein width of a portion located above the semiconductor substrate in a protruding portion of the second main electrode is larger than width of a portion buried in the trench in the protruding portion.

7. The power semiconductor device according to claim **1**, wherein the sixth second-conductivity-type semiconductor layer is formed also on a sidewall of the trench.

8. The power semiconductor device according to claim **1**, wherein insulated gate structure composed of the fourth second-conductivity-type semiconductor layer, the fifth first-conductivity-type semiconductor layer, the second first-conductivity-type semiconductor layer, the gate insulating film, and the control electrode constitutes a planar gate structure.

9. The power semiconductor device according to claim **1**, wherein a gate trench is formed in an upper surface of the semiconductor substrate, part of the gate insulating film is formed on an inner surface of the gate trench, and a lower portion of the control electrode is buried inside the gate trench.

10. The power semiconductor device according to claim **9**, wherein lower surface of the sixth second-conductivity-type semiconductor layer is located below lower surface of the control electrode.

11. The power semiconductor device according to claim **10**, wherein lower surface of a portion buried in the trench in the second main electrode is located below the lower surface of the control electrode.

12. The power semiconductor device according to claim **1**, wherein the sixth second-conductivity-type semiconductor layer is spaced from the fourth second-conductivity-type semiconductor layer, and on side face of a portion buried in the trench in the second main electrode, region between region in contact with the fourth second-conductivity-type semiconductor layer and region in contact with the sixth second-conductivity-type semiconductor layer is in contact with the second first-conductivity-type semiconductor layer.

13. The power semiconductor device according to claim **1**, further comprising a field insulating film provided on the semiconductor substrate in a termination section, and a field plate electrode in a rectangular frame configuration provided on the field insulating film.

14. The power semiconductor device according to claim **13**, wherein lower surface of outer peripheral portion of the field plate electrode is shaped like a staircase, with its lower surface ascending toward outer periphery.